TECHNIQUES TO START THE STOOP CIRCLE (ADLER) ON HIGH BAR

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The stoop circle rearward forward (Adler) is often performed by gymnasts on high bar. The final position, the handstand is a component of judges' execution value. For the stoop circle only the final position is determined by the gymnastics rules. The start position is not declared. There are two main techniques to start the element stoop circle, which we define as "high" and "low" technique. Aims of the research are finding biomechanical differences between the two techniques and deducing requirements for gymnasts. 2D-video analysis from high bar routines of the World Championships 2007 was used. There are more gymnasts performing the "high" technique. We find differences in movement time and maximum angular velocities for hip and shoulder angles. These differences should be considered by coaches and gymnasts.

KEYWORDS: artistic gymnastics, high bar, stoop circle, hip angle, shoulder angle.

INTRODUCTION: The stoop circle rearward forward, also called "Adler" (german word for "eagle") is an old element in artistic gymnastics. It is performed mostly by men on high bar, but also by women on the uneven bars. In the last years this element becomes more important because of the possibility to combine it with another element, especially with flight elements. This combination is important to earn combination points to get a higher difficulty value of the routine. There are different variations for the stoop circle (see Figure 1). Gymnasts perform the element without a turn, with half turn or full turn but always through the handstand. The handstand is a good position for the next flight elements.

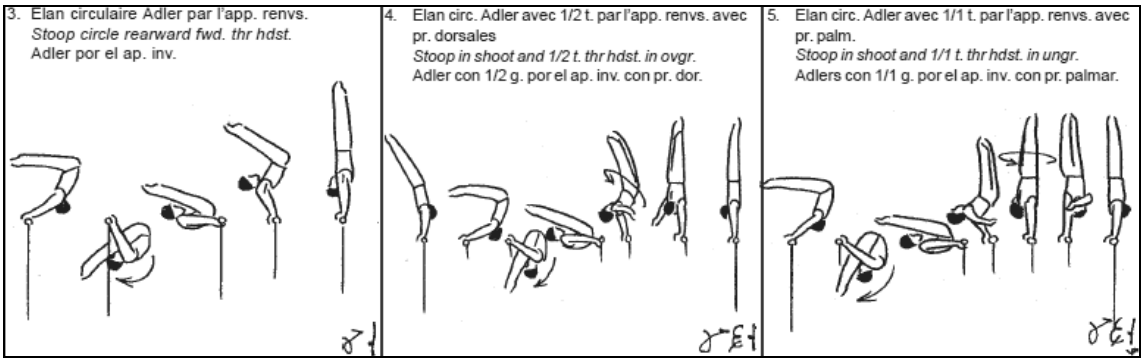

Figure 1. Different variations of the stoop circle in high bar in the Code of points (Féderation Internationale de Gymnastique, 2009, 130).

For the stoop circle (with or without turns) there are two main techniques for the first part of the element (Figure 2 and 3). The first possibility is to start the stoop circle from handstand. The gymnasts finish their giant swing forward and after they reached the vertical line over the high bar (handstand position with open shoulder and hip angle) they stoop in. For the second technique the gymnasts do not finish their giant swing. Shortly after they pass the horizontal line on high bar they bend their shoulder and their hip angle for stoop in. For a better understanding we declare the first technique (stoop in from handstand) as the "high" technique (high centre of mass, CM) and the

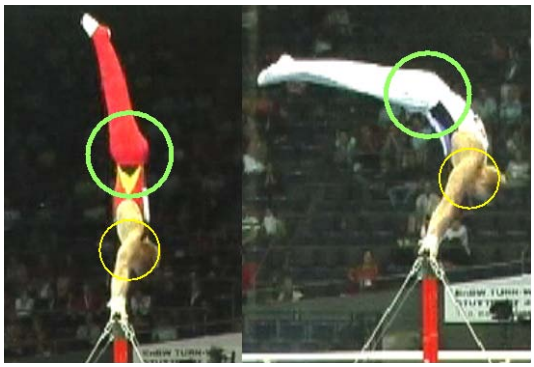

Figure 2. Characteristics to define the two techniques by hip and shoulder angle higher or lower than 160° (left: "high" technique, right: "low" technique).

second technique (stoop in after horizontal) as the “low” technique (lower CM). Using a biomechanical description we separate the stoop circle depending on the hip and shoulder angle at the moment when the CM passing the vertical over the high bar (Figure 2). If the hip and shoulder angles were higher than 160° we have the “high” technique and if the hip and shoulder angles were lower than 160° we define this as the “low” technique.

Figure 3. The two possibilities to start the stoop circle rearward forward (top: “high” technique, bottom: “low” technique).

For the stoop circle rearward forward there are no judge’s rules for the start position. The Code of points (Féderation Internationale de Gymnastique, 2009) and other regulations from the gymnastics Federation (Stoica, 2009) specify only the last position (handstand) of the element. If the gymnast did not reach the handstand position and there is a difference of more than 15° the execution judges deduct 0.1, 0.3 or 0.5 points. Additionally the level of difficulty will be downgraded by the difficulty judges (e.g. from C-value to B-value or no value).
For coaches the questions are “Which technique enable better progression to more advanced skills?”, “Which technique is better to reach the perfect final position (handstand)?” and “Which requirements are important for the different techniques?”. Using a biomechanical approach we can help the coaches to answer especially the last question.
There are a lot of publications concerning different elements on high bar (dismounts, e.g. Hiley & Yeadon, 2003; 2008 and flight elements e.g. Hiley, Yeadon & Buxton, 2007), but there was no paper found for the stoop circle.

METHOD: We recorded 160 men’s high bar routines at the Artistic Gymnastics World Championships 2007 in Stuttgart in all parts of the competition (qualification and finals). A descriptive frequency analysis of the different techniques was the first step. A two-dimensional video analysis (fixed DV-Camera Panasonic NV-GS 300, 50 Hz, 2D-DLT) was utilized for detailed analysis. We digitized 7 body landmarks (ankle, knee, hip, shoulder, head, elbow and wrist) from 15 stoop circles and calculated the CM (Saziorski, Aruin & Selujanow, 1984) and the hip and shoulder angle (smoothed data by cubic spline function). To compare the two techniques we divide the stoop circle in 4 phases, which are defined by the position of the CM related to the high bar (Figure 4).

- Phase 1: CM from left horizontal to upper vertical
- Phase 2: CM from upper vertical to right horizontal
- Phase 3: CM from right horizontal to lower vertical
- Phase 4: CM from lower vertical to left horizontal

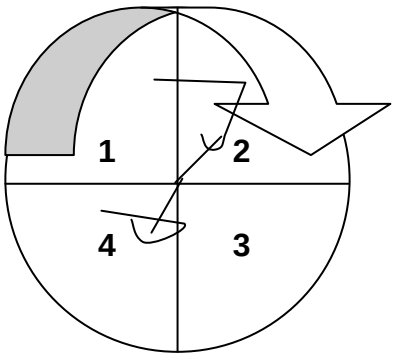

Figure 4. Phases of the stoop circle.

If the movement is executed counter clockwise left and right horizontal is switched. After the 4th phase the gymnast start the turn for stoop circle with half or full turn.

RESULTS: From 160 men's high bar routines 100 include one ore more stoop circles. 57 percent of all stoop circles were performed with the "high" technique. Only for stoop circles with half turn the frequency is near equal (Table 1).

Table 1. Frequency of stoop circles

Variation of stoop circle	"High" Technique	"Low" Technique
Without turn to handstand	34	26
With half turn to handstand	24	25
With full turn to handstand	21	8
Sum of all variations	79	59

If we compare the movement time for the two techniques for the four phases the "high" technique has longer first and second phase but shorter Phase 3 and 4 (Table 2).

Table 2. Mean time [s] for the phases of stoop circles

Phase	"High" Technique	"Low" Technique
1	0,81 (±0,11)	0,64 (±0,08)
2	0,58 (±0,14)	0,43 (±0,05)
3	0,24 (±0,06)	0,33 (±0,19)
4	0,30 (±0,12)	0,33 (±0,16)

Table 3. Mean maximum velocities [°/s] for the phases of stoop circles

	"High" Technique		"Low" Technique	
Phase	shoulder	hip	shoulder	hip
1	218 (±54)	171 (±52)	238 (±39)	246 (±69)
2	406 (±85)	506 (±104)	322 (±69)	486 (±233)
3	333 (±86)	168 (±64)	298 (±29)	141 (±46)
4	430 (±115)	369 (±107)	483 (±66)	320 (±114)

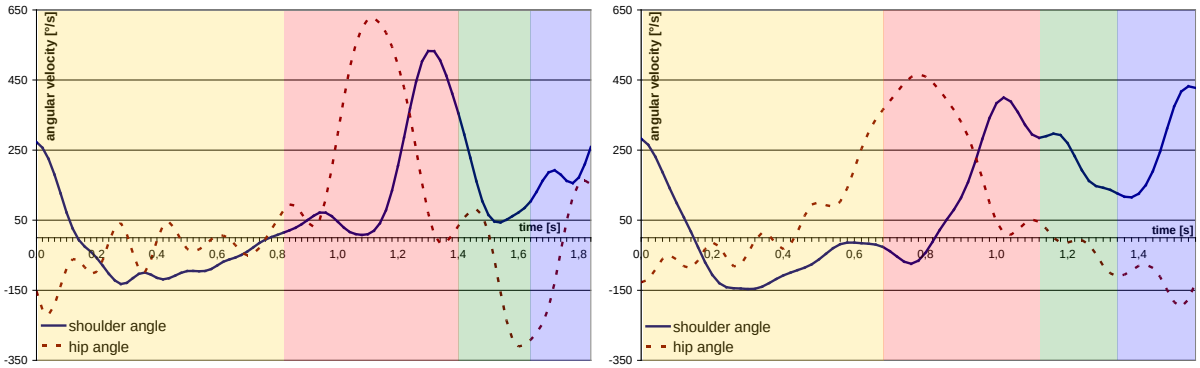

Figure 5. Examples for angular velocities of "high" (left) and "low" (right) Techniques of the stoop circles (phases separated by the coloured background).

For the coaches especially the velocities of hip and shoulder angle were interesting. In the downwards Phases (2 and 3) the absolute maximum angular velocities of hip and shoulder

angle are higher for the “high” technique (Table 3). The examples in Figure 5 should illustrate these findings. The gymnasts with the “high” technique (left) start his movement of hip and shoulder angle later but must do it faster.

DISCUSSION: More gymnasts prefer the “high” technique with the late stoop in. But our findings show this technique make higher demands on the gymnasts. They must bend their hip and shoulder faster than with the “low” technique. Our first results give us no answer why gymnasts use the “high” technique with greater demands. One assumption of the coaches was that body mass and height of the gymnasts is one reason for choosing “high” or “low” technique. Using official information from the gymnastics federation with height and mass of the gymnast we could not find differences between the gymnasts using “high” or “low” technique.
Maybe the question is not only answerable with biomechanical data. It could be also a question of which movement has the greater effect on judges and spectators. This is a question of aesthetics. Maybe it is more impressively to have a slow start of the stoop circles and than a faster movement (“high” technique) compared to the slower movement with an early start (“low” technique).

CONCLUSION: Both techniques of the stoop circle rearward forward were performed successful by many gymnasts. But our analysis with kinematic data shows different requirements in hip and shoulder angle for these techniques. Using the “high” technique higher angular velocities must be performed in hip and shoulder angles. Coaches and gymnasts should consider this in their training especially in strength training for hip and shoulder angle. Further research should include the calculation of energy and joint torques. Applying these data to a simulation model could be used for movement optimization.

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